GROWTH AND SPECIES EVALUATION OF SOME UNMANAGED UPLAND HARDWOODS IN SOUTHERN ILLINOIS

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The upland-mixed-hardwood and oak-hickory forests are by far the most extensive types in southern Illinois and in the whole Central Hardwood region. Practically no stands remain entirely uncut and few have escaped fire and grazing. The result is a large area of unmanaged forests in relatively small, scattered woodlands. A brave beginning in forest management has been made. Some woodlands are being well handled, but we still lack information such as, species to favor, the size to which trees should grow, and the optimum diameter distribution, stocking, and volume of managed stands. Until such information is supplied, any action program must operate on a partly makeshift basis.

The present study was made on the Kaskaskia Experimental Forest in Hardin County, Illinois, for the purpose of determining the volume growth and stand structure of unmanaged stands of the two broad upland types. These data were needed as a basis for management studies being undertaken on the area. This report briefly describes the present condition of the unmanaged upland stands, and presents some conclusions and recommendations for converting an unmanaged forest to a managed forest.

GENERAL DESCRIPTION OF STUDY

The study area was a 1200-acre tract of typically rough upland terrain characterized by steep north and south slopes. Their gradient averages about 20 percent and they are separated by rather narrow stream bottoms and ridge tops. The tract was cut over for yellow-poplar and the better quality oak in the early 1890's. Since that time no general cutting has been done and the stands have been entirely unmanaged. Until about 1935, fires were frequent and have greatly reduced the value of the present timber stands. The mixed-hardwood type (fig. 1) is found chiefly on the northerly slopes and in the coves, and the oak-hickory type on the ridge tops and the southerly slopes (fig. 2).

Figure 1.--Typical mixed hardwood stand containing yellow-poplar as well as mixed oak and hickory. The merchantable height is relatively great.

Figure 2.--A typical oak-hickory stand containing mixed oak and hickory. Saw-timber trees are characterized by their short boles.

During the fall of 1947, the trees on 180 1/20-acre sample plots were measured to determine volume growth during the past 10 years. Sampling was done by dividing the approximately 600-acre area of each forest type into 30 parts and taking 3 random 1/20-acre plots in each part, that is, 90 plots in each type. The accuracy of the results depends on the number and size of the plots taken. Totals for volume, growth, and basal area per acre are based on an adequate sample. Corresponding figures for individual species are less accurate, especially for the larger diameters.

Those measurements necessary to determine growth--including species, tree diameter, merchantable height, form class, radial growth during the last 10 years, and bark thickness--were taken on all live trees 4.6 inches d.b.h. and larger.1/

1/ Diameter at breast height, i.e., 4.5 feet above average ground level.

STAND DESCRIPTION

STOCKING AND VOLUME

Stocking, as expressed by number of trees per acre and basal area, is slightly better in the mixed-hardwood type (table 1). Saw-timber board-foot volume per acre is one-and-a-half times as great in the mixed hardwood as in the oak-hickory type. Most of the difference in volume can be attributed to the greater merchantable height of the mixed-hardwood stands (fig. 3). About 15 percent of the basal area of both types is in trees that are presently and potentially merchantable only for fuelwood. These trees were considered to be cull trees and are not included in the volume and growth data.

Table 1.--Number of trees, basal area, and volume per acre by broad type

Tree class and unit	Mixed-hardwood	Oak-hickory
Pole-size, 1/ merchantable.....number..	62	65
Pole-size, cull.....number..	20	15
Saw-timber size, 2/ merchantable.....number..	33	29
Saw-timber size, cull.....number..	4	4
Merchantable.....sq. ft. basal area..	58	51
Cull.....sq. ft. basal area..	10	9
Saw-timber volume.....bd. ft. Int. 1/4-inch rule..	5,600	3,650
Total merchantable volume.....cu. ft..	1,050	725

1/ D.b.h. 4.6 to 10.5 inches inclusive.
2/ D.b.h. 10.6 inches and larger.

GROWTH

Saw-timber board-foot growth per acre is twice as great in the mixed-hardwood type as in the oak-hickory type (table 2). This greater growth results from a larger radial growth on a longer merchantable stem (fig. 3).

The simple-interest cubic-volume growth by diameter class (table 3) shows the usual greater percentage growth for the smaller trees. In addition, table 3 shows that the greater percentage growth for mixed hardwoods is contributed entirely by the saw-timber sizes. This shows that on better sites rapid growth continues into saw-timber classes, and that on poorer sites growth drops off rapidly as trees increase in size. It

indicates again2/ that the carrying capacity or growth potential of a site may not be fully expressed until trees reach approximately saw-timber size.

Table 2.--Annual growth by broad type

Growth and unit	Mixed-hardwood	Oak-hickory
Saw-timber growth per acre, bd.ft.Int.1/4-inch rule.	144.0	72.0
Total growth per acre.....cu. ft..	22.5	14.5
Saw-timber growth rate...percent, based on bd. ft..	3.5	2.5
Total growth rate.....percent, based on cu. ft..	2.8	2.5

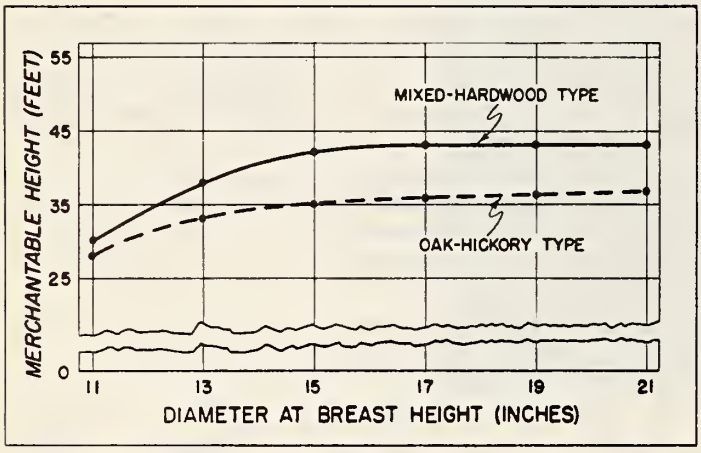

Figure 3.--Relationship between merchantable height and breast-high diameter of merchantable saw-timber trees for two forest types.

Table 3.--Cubic-volume growth rate (simple interest) by diameter class and broad type

D.b.h. class (Inches)	Mixed-hardwood	Oak-hickory
	Percent	Percent
5 - 7	8.6	8.9
8 - 10	3.7	4.0
11 - 18	3.0	2.1
19 and larger	1.4	1.3

2/ Lorenz, R. W., and Spaeth, J. Nelson. The growth of conifers on prairie soil. Jour. Forestry, 45: 253-256. 1947

STAND COMPOSITION

The general distribution of basal area by diameter class for the two broad types is similar except that the mixed-hardwood type has a slightly greater saw-timber basal area (table 4). White oak and scarlet oak have the greatest basal area in mixed-hardwood stands and black oak in oak-hickory stands (figs. 4 and 5). The mixed-hardwood type has no post oak or blackjack oak and the oak-hickory no yellow-poplar. Percentage differences in volume, merchantable height, and growth between the two types are much greater than differences in basal area.

Table 4.--Basal area per acre by diameter class and broad type

D.b.h. class (Inches)	Mixed-hardwood	Oak-hickory
	Square feet	Square feet
5 - 7	10	10
8 - 10	12	10
11 - 18	33	30
19 and larger	13	10

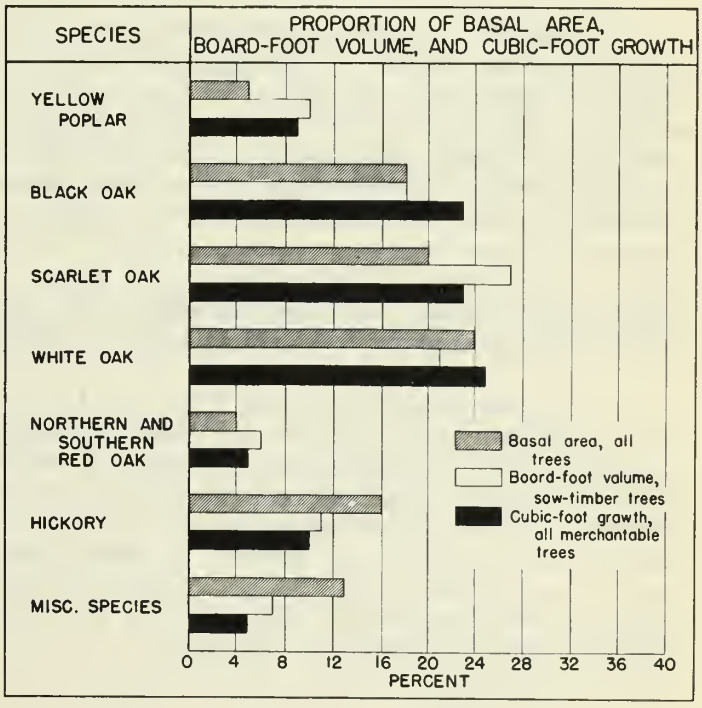

Figure 4.--Proportion of basal area, board-foot volume, and cubic-foot growth in the mixed-hardwood type by principal species.

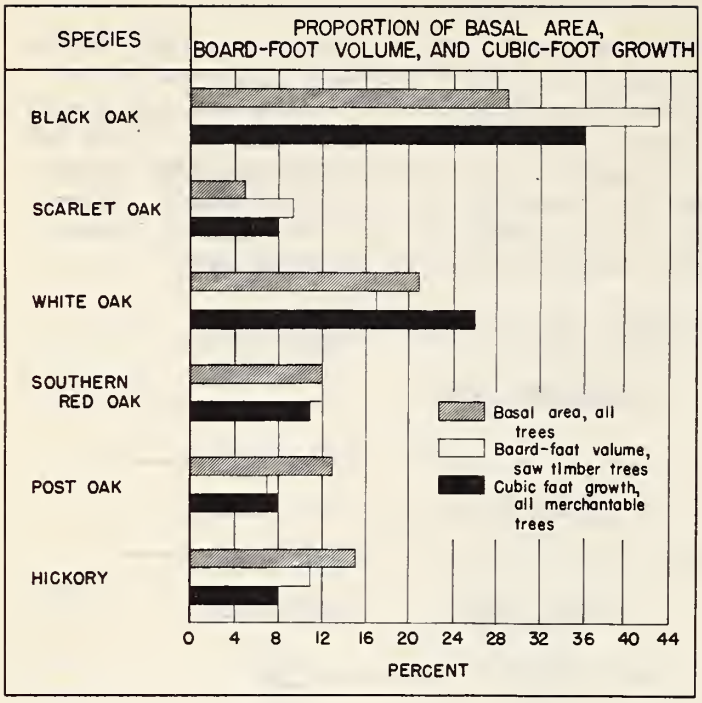

Figure 5.--Proportion of basal area, board-foot volume, and cubic-foot growth in the oak-hickory type by principal species.

SPECIES EVALUATION

Figures 4 and 5 show the relative basal area, saw-timber volume, and cubic-foot growth by species for the two broad types. The basal area bars show the proportion of the total basal area occupied by the principal species in the stand. This should be compared with the proportion of volume and growth contributed by that species. Table 5 gives the direct ratio between the cubic-foot growth percent and basal-area percent for the different species and species groups. The ratios are a measure of each species' contribution to the growth of the stand as compared to the space it occupies in the stand. Figures 4 and 5 and table 5 show that hickory and the miscellaneous species (mostly blackgum) make a poor quantitative contribution to the stand.

For the mixed-hardwood type, yellow-poplar, northern red oak, black oak, white oak, and scarlet oak show a favorable ratio of volume and growth to basal area. Scarlet oak, however, is usually characterized by heavy defect and should be regarded as a strictly short-rotation (about 50 years) species. In the oak-hickory type, scarlet, black, and white oak have the best ratio of volume and growth to basal area. The favorable showing of scarlet oak probably should be discounted except as a short-rotation species. Post oak has a value on the poorest sites where no better hardwood species will produce sawlogs.

Table 5.--Ratio of cubic-foot growth percent[1]/ and basal area percent[2]/ by species and broad type

Species	Mixed-hardwood	Oak-hickory
Yellow-poplar	1.80	-
Black oak	1.28	1.24
Northern red oak and southern red oak	1.25	-
Scarlet oak	1.15	1.60
White oak	1.04	1.13
Southern red oak	-	0.92
Post oak	-	0.62
Hickory	0.63	0.53
Miscellaneous	0.38	-

1/ Cubic-foot merchantable-stem growth of each species expressed as a percent of total growth of the stand.
2/ Square-foot basal area of each species expressed as a percent of total basal area of the stand.

CONCLUSIONS

The conclusions from this study that have some bearing on the management of similar upland hardwood stands are:

1. Cull trees accounted for about 15 percent of the total basal area of the two important types. Twenty-two percent of all pole-sized trees were culls. Although not recorded in the study, many of the merchantable trees were partly defective or of poor form.

2. Volume growth on merchantable stems in both types was low in comparison with potential growth--144 board feet per acre per year for the mixed-hardwood type and 72 for the oak-hickory.

3. The difference in volume per acre between the two types is caused chiefly by the greater merchantable height in the mixed-hardwood type. Difference in volume growth is caused by the greater merchantable height and greater radial growth in the mixed-hardwood type.

4. The difference in growth percent between pole-sized and sawtimber trees is greater in oak-hickory than in mixed-hardwood stands. This points toward a lower growth potential for oak-hickory sites and indicates that stands on these sites are heavier stocked in proportion to carrying capacity than are the mixed-hardwood stands.

5. In mixed-hardwood stands, hickory and miscellaneous species (mostly blackgum) constitute 29 percent of the total basal area of noncull trees. These species have the smallest growth and volume in relation to their basal area. Yellow-poplar, which has the best relationship between growth and volume and basal area constitutes only 5 percent of the basal area of the type. The best species, yellow-poplar, white oak, black oak, and red oak, make up 51 percent of the stand basal area. The other 49 percent is hickory, scarlet oak, and miscellaneous species.

6. In the oak-hickory type, the species having the largest growth and volume in relation to basal area are black oak, scarlet oak, and southern red oak. Considering the poor quality of scarlet-oak logs and the ability of post oak to produce sawlogs on the poorest sites, the best species are probably black oak, white oak, post oak, and southern red oak. These constitute about 70 percent of the basal area of noncull trees. Hickory, scarlet oak, blackjack oak, and miscellaneous species make up the other 30 percent.

7. Combining both culls and poor species, the basal area of undesirable trees is about 55 percent of the total for the mixed-hardwood type and 40 percent for the oak-hickory type.

RECOMMENDATIONS

The following simple recommendations for managing upland stands are derived chiefly from the above general conclusions. The recommendations are not comprehensive but are limited by the scope and accuracy of the present study. They are given to help forest managers increase the growth and the general quality of similar upland stands by silvicultural practices aimed at concentrating the growth on the best trees.

1. The stands should have one or more improvement cuts to eliminate all culls and all defective or poorly formed trees.

2. The prevailing slow growth of the stands can be improved by gradually eliminating slow-growing species and short-bodied trees. The growth potential of the site should, as far as possible, be concentrated on long-bodied individuals of the best species.

3. In mixed-hardwood stands the marking practices should discriminate against hickory and blackgum of all sizes.[2/] In marking,

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2/ Data from this study and close observation indicate strongly that beech and maple in southern Illinois are also of poor growth and very low quality. They should be discriminated against even more than hickory. Where good specialty markets are available for high-quality hickory, a few of the best individual trees may be, in spite of their slow growth, valuable components of the stand.

all scarlet oak should be scrutinized carefully, especially with regard to quality and defect. This species should be grown on a short rotation. Yellow-poplar, white oak, northern red oak, and black oak should be favored.

4. In oak hickory stands (as here defined) discriminate against hickory and blackjack oak. Favor white oak and black oak on the better sites and black oak, southern red oak, and post oak on the poorer sites. Favor scarlet oak only as a short rotation species.

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